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PATTERNS OF GROUNDWATER TABLE FLUCTUATIONS AND ESTIMATION OF EVAPOTRANSPIRATION ON RUOERGAI PEATLAND, CHINA

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Introduction

Groundwater table in undisturbed peatland fluctuates with various hydrological phenomena, such as precipitation, inflow, evapotranspiration, and discharge. This fluctuations of groundwater table can be interpreted as the reflection of the water balance of peatland. The pattern of fluctuations vary according to the hydrological environment of the peatland, i. e., topography, structure of surface peat layer, vegetation, influence of drainage, climate, etc.. From this pattern of groundwater table fluctuations, estimation of various hydrological information can be performed.

Groundwater tables and its fluctuations were observed on Ruoergai peatland, Sichuan province, China. Investigation was carried out to analyze fluctuations of groundwater table, to estimate amount of evapotranspiration, and to evaluate the influence of the structural difference of surface peat layer to the groundwater table fluctuations.

Outline of The Survey

The observations and surveys were performed on Waqie and Kaharqiao, Ruoergai peatland, Sichuan, China (Fig. 1).

The measurement of groundwater table in Waqie was carried out momentary on 40 m×40 m grid points placed in 120 m×160 m extent (Fig. 2). Micro-topography near observation point showed developed hummock-hollow structure, with waterlogged hollows. From the momentary measurement of groundwater table on grid points, the groundwater tables are generally low on slope and high in the base.

In Kaharqiao, a 900 m long survey line was established from hill to the base. Pipes for momentary measurement of groundwater table were installed to determine the cross-sectional levels of groundwater table along the survey line. Also water level recorders were set at two points, one on the slope and another on the

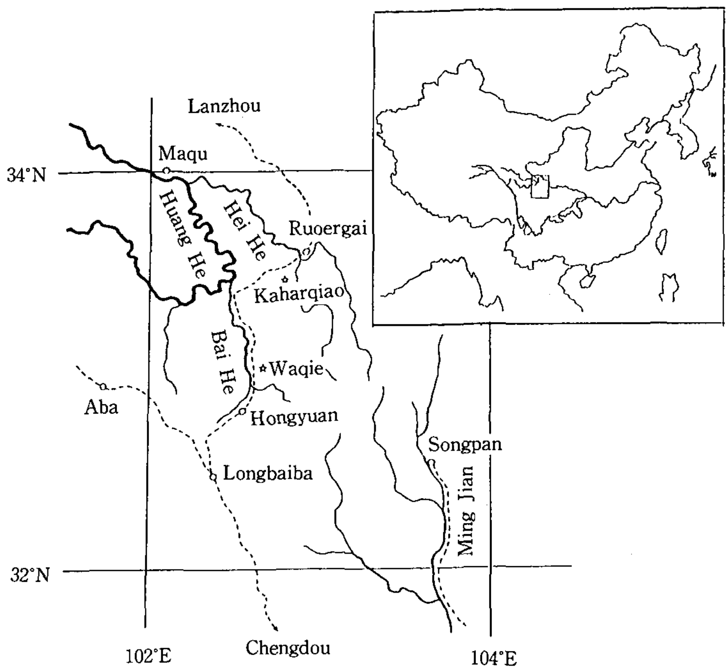


Fig. 1. Survey area, Ruoergai peatland.

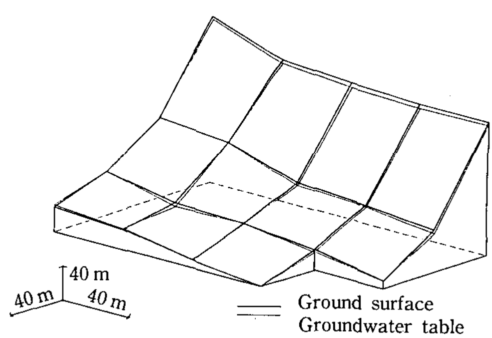


Fig. 2. Ground surface and groundwater table, Waqie.

base, to observe continuous records of groundwater table fluctuations. The elevation difference was 1.2 m, and the distance was 345 m between the two points (Fig. 3 and 4).

At the slope observation point of Kaharqiao, the water level recorder was set in the hollow of micro-topography. The relative height between the top of hummock and the bottom of hollow is about 30 cm. The ground near the base observation point is so-called "quaking bog", which quaked when people walked on.

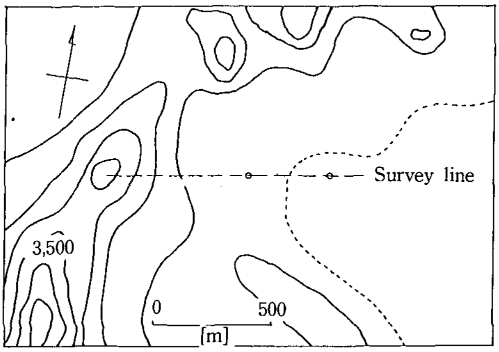


Fig. 3. Survey line and the location of water level recorder, Kaharqiao. (interval of conter = 20 m)

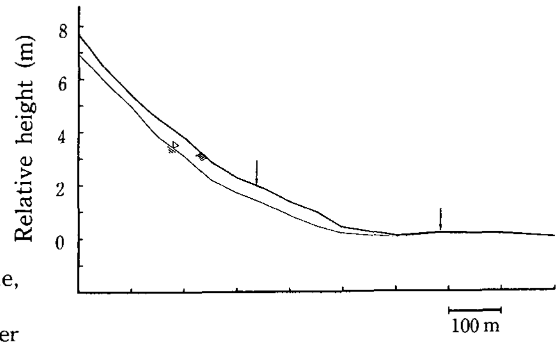


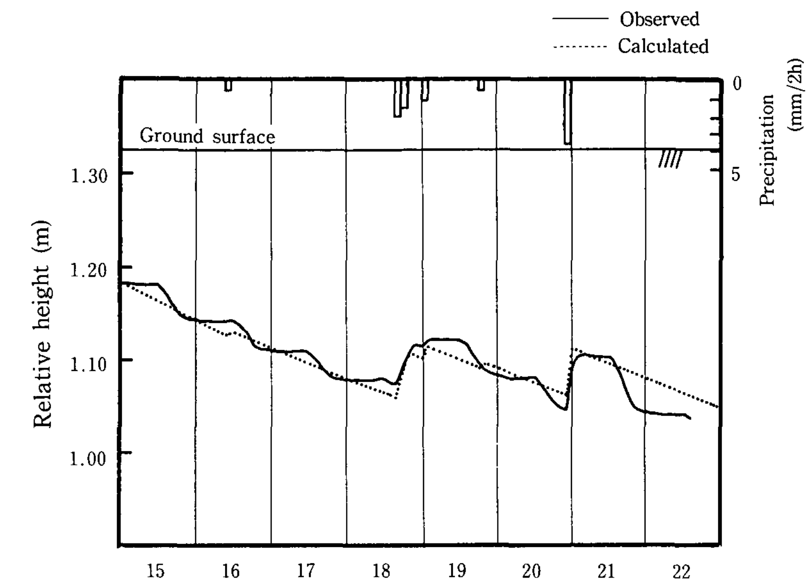
Fig. 4. Cross section of survey line, Kaharqiao.
↓ : location of water level recorder

Groundwater Table and its Fluctuations in Kaharqiao

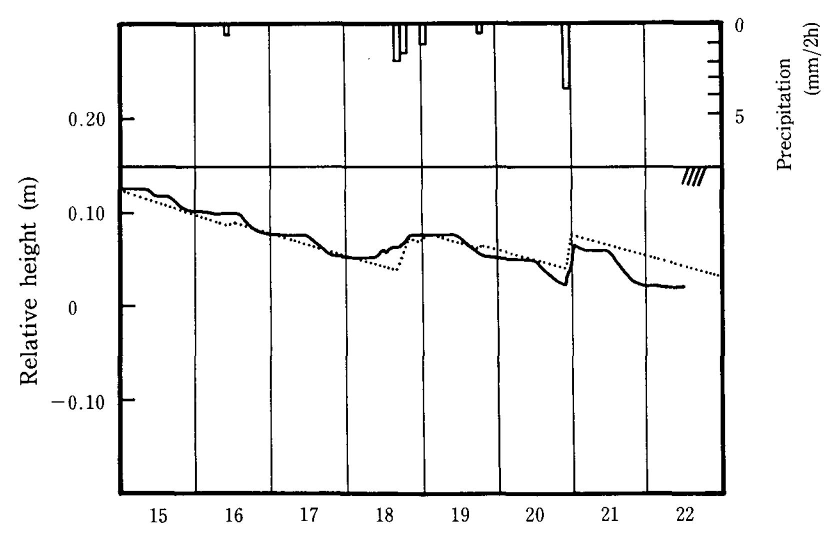
The groundwater table was generally low on the slope and very high on the base in Kaharqiao. There was total precipitation of 9.5 mm during the observation period of July 14 to 22, 1988. The precipitation of 4.5 mm on July 18 and 3.5mm on July 20 caused groundwater table rises (Fig. 5), but other smaller precipitation did not. The groundwater table rise on the slope was greater than that of on the base for both precipitations. The 3.5 mm on July 20 caused a groundwater table rise of 60 mm on the slope and 40 mm on the base, seventeen and eleven times larger than the precipitation.

Groundwater table fell remarkably in the daytime, but very little at night. This suggests that the decline of groundwater table depends mainly on evapotranspiration. The amount of fall in groundwater table in the daytime on the slope was greater than that on the base, similar to the difference of rise of the groundwater table due to precipitation. This supposed to be caused by differences in peat porosity in surface layer, with the peat on the slope having relatively lower porosity than on the base, and resulting in greater fluctuations in the groundwater table for the same amount of precipitation/evapotranspiration.

Groundwater tables calculated by the tank model are also shown on Fig. 5.



(a) slope



(b) base

Fig. 5. Fluctuations of groundwater table at Kaharqiao.

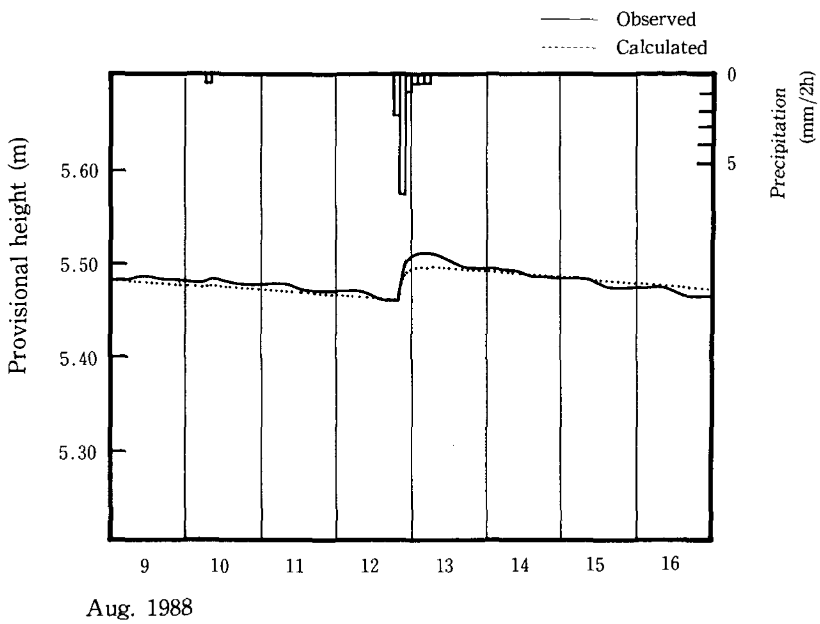
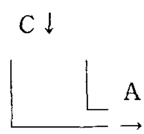


Fig. 6. Fluctuations of groundwater table at Ochiai, Sarobetsu peatland.

TABLE 1. *Coefficients of the tank model for groundwater table in* Kaharqiao and Sarobetsu.

Coefficient	Kaharqiao slope	Kaharqiao base	Sarobetsu Ochiai
C	17	11	3.5
A	0.011	0.007	0.002



Each coefficient of the tank model is adjusted to let output of the model to be fitted with actual groundwater table. The well fitted solution of the tank model expresses the property of groundwater table fluctuations on its coefficients of the tank model. Factor C of the tank model represents degree of groundwater rise per precipitation, whereas coefficient A represents the rate of groundwater table decline. Both coefficient C and A of the tank model applied for Kaharqiao are larger on the slope than on the base, resulting in larger fluctuations in the groundwater table.

Groundwater table fluctuations of bog area in Sarobetsu peatland, Hokkaido, Japan, and its tank model is presented for comparison (Fig. 6). Compared with Sarobetsu, the groundwater table fluctuations in Kaharqiao are wide and the coefficients of the model are large (Table 1). Groundwater table in Kaharqiao peatland showed remarkable rises and falls respond to precipitation and evapotranspiration. This may be closely related to differences in the quality of the peat as described later.

Estimation of Evapotranspiration on Kaharqiao

Evapotranspiration was estimated in Kaharqiao from the groundwater table fluctuations, using the same method with UMEDA and INOUE[1] which were applied at Bibai peatland. Similar method was also applied in an afforested mire of Finland by HEIKURAINEN[2]. This method supposing the ratio of groundwater table fall to the amount of evapotranspiration is same to the ratio of groundwater table rise to the amount of precipitation. If the rise of water table includes the influence of inflow from surrounding areas, or the fall includes the influence of gravitational drainage, amount of these influence should be deducted from whole change of water table before estimating evapotranspiration.

The Kaharqiao observations showed no apparent influence of inflow from the surroundings, or of gravitational drainage, on the hydrograph of groundwater table fluctuations. No remarkable surface water movement supposed to be occurred after the precipitation of the observation period. Also there was no remarkable gravitational drainage, for there was no fall of groundwater table at night.

Supposing the matter above, the evapotranspiration on Kaharqiao was estimated (Table 2). The average daily evapotranspiration during the observation period was 2.5 mm on the slope and 2.4 mm on the base. These values are similar to those measured on peatlands in Hokkaido.

TABLE 2. Estimated evapotranspiration, Kaharqiao, July 1988 [mm]

day	15	16	17	18	19	20	21	Average
precipitation	–	0.5	–	4.5	0.5	3.5	–	–
evapotranspiration								
slope	2.2	1.6	1.7	–	2.4	3.5	3.4	2.5
base	2.2	1.7	2.1	–	2.1	3.6	2.7	2.4

Groundwater Table Fluctuations and Qualitative Characteristics of Peat

Difference in the patterns of groundwater table fluctuations between the slope and the base in Kaharqiao depends on the local quality of peat rather than topography. There was no water movement due to surface runoff or gravitational drainage with low precipitation during observation period ; falls in the groundwater table depended mainly on evapotranspiration ; the evapotranspiration on the slope and on the base were nearly equal ; there were apparent differences in the patterns of groundwater table fluctuations, which reflected in differences of the coefficients of the tank model.

The difference in the patterns of groundwater table fluctuations depend on qualitative difference of peat, especially pore formation. Void ratio is 9.1 on the slope and 7.6 on the base, and ignition loss is 54% on the slope and 64% on the base. The peat on the slope contains fewer "external" pores affecting water movement during short periods, and results larger fluctuations of the groundwater table.

Differences in patterns of groundwater table fluctuations between Sarobetsu and Kaharqiao supposed to be due to similar reasons. Magnifications of cross sections of Sarobetsu peat composed *sphagnum* spp, appears rough with high porosity. The void ratio of Sarobetsu peat is 18.8 and ignition loss is 90%, which signifying more pores in Sarobetsu peat than of Kaharqiao. The patterns of groundwater table fluctuations in Sarobetsu and Kaharqiao reflect differences in peat quality.

Summary

Groundwater table and its fluctuations were observed on Ruoergai peatland, Sichuan province, China. Investigation was carried out to analyze fluctuations of groundwater table, to estimate amount of evapotranspiration, and to evaluate the influence of the structural difference of surface peat layer to the groundwater table fluctuations. Average of estimated daily evapotranspiration in Kaharqiao was 2.5 mm on the slope and 2.4 mm on the base of the hill. The difference in the patterns of groundwater table fluctuations depend on quantity of peat, especially its pore formation.

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